

CS 267 – Fall 2009 – Homework Assignment 1

Due Monday, October 12th

Do not discuss the problems with anyone other than the instructor.

1. Consider the following transition system $M = (AP, S, R, S_0, L)$ with the set of states $S = \{0, 1, 2, 3, 4\}$, the initial set of states $S_0 = \{0\}$, the transition relation $R = \{(0, 1), (1, 2), (2, 3), (3, 4), (3, 1), (4, 4)\}$, the set of atomic propositions $AP = \{p, q\}$ and the labeling function $L : S \rightarrow AP$ where $L(0) = \emptyset$, $L(1) = \{p\}$, $L(2) = \{p\}$, $L(3) = \{p, q\}$, and $L(4) = \{q\}$.

(a) For each of the following temporal formulas show the states which satisfy them:

EGp , EGq , AGp , AGq , EFp , EFq , AFp , AFq , $pEUq$, $pAUq$, $AG(AFp)$, $AG(AFq)$.

(b) Which of these properties are satisfied by the transition system M ? For the ACTL properties (the properties that only contain the path quantifier A) that are not satisfied by M give a counter-example execution path.

2. Show that temporal operators EX, EU and AU form a basis for CTL by writing other CTL temporal operators in terms of EX, EU and AU.

3.

```
boolean a, b;  
initial: a = false and b = false;
```

```
P1 :: while True do  
1:   a := true;  
2:   a := b;  
   endwhile
```

```
P2 :: while True do  
1:   b := false;  
2:   b := a;  
   endwhile
```

```
P = cobegin P1 || P2 coend
```

(a) Draw the transition system for the above concurrent program. The variables a and b are shared, the assignments are atomic and each process loops between two program points (1 and 2).

(b) For each of the following temporal formulas show the states which satisfy them (for the formulas that contain more than one temporal operator also show the states that satisfy the subformula). Identify the temporal formulas which are satisfied by the whole transition system:

$AG(AF(a = b))$, $AG(AF(a \neq b))$, $AG(pc1 = pc2 = 1 \Rightarrow a = b)$, $AG(pc1 = pc2 = 2 \Rightarrow AX(a = b))$